CLAIMS

1. A high-strength bolted connection structure with no fire protection, the high-strength bolted connection structure having the fire resistance of a steel structure comprising columns and/or beams, characterized in that ultra-high-strength bolts having a bolt tensile strength (TS) at room temperature of 1200 N/mm^2 or higher and excellent fire resistance with a bolt shear proof stress ($b\tau t$) at 650°C satisfying the relation <1> below, are used:

$$b\tau t \geqq \mu \times N_0/(\nu \times bAs) \quad <1>$$

where $b\tau t$: bolt shear proof stress at high temperature (N/mm^2)

$b\tau t = TSt/\sqrt{3}$

TSt : tensile strength of the bolts at high temperature (N/mm^2)

μ : coefficient of slip at room temperature

N_0 : design bolt tension (N)

ν : safety factor for long-term load

bAs : cross-sectional area of bolt shank (mm^2).

2. A high-strength bolted connection structure with no fire protection according to claim 1, wherein, in said high-strength bolted connection structure, the long term allowable shear force (Qs) of said beam at room temperature satisfies the relation <2> below:

$$Qs \leqq \{ns \times b\tau + (nf - ns) \times b\tau t\} \times bAs \quad <2>$$

where Qs : long term allowable shear force of the beam at room temperature (N)

$Qs = fs \times Ab$

fs : long term allowable shear proof stress of the beam (N/mm^2)

Ab : cross-sectional area (mm^2)

ns : number of tension bolts in the floor slab on upper flange side of the beam

bτ : shear proof stress of bolt at room temperature (N/mm^2)

$b\tau = TS/\sqrt{3}$

TS : tensile strength of bolt at room temperature (N/mm^2)

nf : number of tension bolts on the upper flange side of the beam

bτt : shear proof stress of bolt at high temperature (N/mm^2)

$b\tau t = TSt/\sqrt{3}$

TSt : tensile strength of bolt at high temperature (N/mm^2)

bAs : cross-sectional area of bolt shank (mm^2).

3. A high-strength bolted connection structure with no fire protection according to claim 1 or 2, wherein said high-strength bolted connection structure is composed of sets of a high-strength bolt, a nut, and a washer, and joint metals, and wherein said nut and washer are a general structural hexagon nut and a structural high strength plain washer for which no fire resistance is provided.

4. A high-strength bolted connection structure with no fire protection according to claim 1 or 2, wherein said high-strength bolted connection structure is composed of sets of high strength bolt, a nut, and a washer, and joint metals, and wherein a part or all of said joint metals are formed of steel material having an assured high-temperature strength.

5. A high-strength bolted connection structure with no fire protection according to claim 1 or 2, wherein, in said high-strength bolted connection structure, a part or all of said columns and/or beams used are formed of steel material having an assured high temperature strength.

6. A high-strength bolted connection structure with no fire protection according to claim 1 or 2,

wherein said high-strength bolt is a ultra-high-strength bolt which contains, in % by weight, C: 0.30 ~ 0.45%, Si: less than 0.10%, Mn: more than 0.40% ~ less than 1.00%, P: less than 0.010%, S: 0.010% or less, Cr: 0.5% or more ~ less than 1.5%, Mo: more than 0.35% ~ less than 1.5%, V: more than 0.3% ~ 1.0% or less, with the balance being Fe and unavoidable impurities, and which has excellent fire resistance and resistance to delayed fracture such that following relations <3>, <4> are satisfied:

$$TS \leqq (1.1 \times T + 850) \quad <3>$$

$$TS \leqq (550 \times Ceq + 1000) \quad <4>$$

where TS : tensile strength of the high strength bolt at room temperature (N/mm^2)

T : tempering temperature (°C)

Ceq : carbon equivalent (%)

$Ceq = C + (Mn/6) + (Si/24) + (Ni/40) + (Cr/5) + (Mo/4) + (V/14)$.

7. A high-strength bolted connection structure with no fire protection according to claim 3, wherein said high-strength bolt is an ultra-high-strength bolt which contains, in % by weight, C: 0.30 ~ 0.45%, Si: less than 0.10%, Mn: more than 0.40% ~ less than 1.00%, P: less than 0.010%, S: 0.010% or less, Cr: 0.5% or more ~ less than 1.5%, Mo: more than 0.35% ~ less than 1.5%, V: more than 0.3% ~ 1.0% or less, with the balance being Fe and unavoidable impurities, and which has excellent fire resistance and resistance to delayed fracture such that following relations <3>, <4> are satisfied:

$$TS \leqq (1.1 \times T + 850) \quad <3>$$

$$TS \leqq (550 \times Ceq + 1000) \quad <4>$$

where TS : tensile strength of the high strength bolt at room temperature (N/mm^2)

T : tempering temperature (°C)

Ceq : carbon equivalent (%)

Ceq = C + (Mn/6) + (Si/24) + (Ni/40) + (Cr/5) + (Mo/4) + (V/14).

8. A high-strength bolted connection structure with no fire protection according to claim 4, wherein said high-strength bolt is an ultra-high-strength bolt which contains, in % by weight, C: 0.30 ~ 0.45%, Si: less than 0.10%, Mn: more than 0.40% ~ less than 1.00%, P: less than 0.010%, S: 0.010% or less, Cr: 0.5% or more ~ less than 1.5%, Mo: more than 0.35% ~ less than 1.5%, V: more than 0.3% ~ 1.0% or less, with the balance being Fe and unavoidable impurities, and which has excellent fire resistance and resistance to delayed fracture such that following relations <3>, <4> are satisfied:

$$TS \leqq (1.1 \times T + 850) \quad <3>$$

$$TS \leqq (550 \times Ceq + 1000) \quad <4>$$

where TS : tensile strength of the high strength bolt at room temperature (N/mm^2)

T : tempering temperature (°C)

Ceq : carbon equivalent (%)

Ceq = C + (Mn/6) + (Si/24) + (Ni/40) + (Cr/5) + (Mo/4) + (V/14).

9. A high-strength bolted connection structure with no fire protection according to claim 5, wherein said high-strength bolt is an ultra-high-strength bolt which contains, in % by weight, C: 0.30 ~ 0.45%, Si: less than 0.10%, Mn: more than 0.40% ~ less than 1.00%, P: less than 0.010%, S: 0.010% or less, Cr: 0.5% or more ~ less than 1.5%, Mo: more than 0.35% ~ less than 1.5%, V: more than 0.3% ~ 1.0% or less, with the balance being Fe and unavoidable impurities, and which has excellent fire resistance and resistance to delayed fracture such that following relations <3>, <4> are satisfied:

$$TS \leqq (1.1 \times T + 850) \quad <3>$$

$$TS \leqq (550 \times Ceq + 1000) \quad <4>$$

where TS : tensile strength of the high strength bolt at room temperature (N/mm^2)

T : tempering temperature (°C)

Ceq : carbon equivalent (%)

$Ceq = C + (Mn/6) + (Si/24) + (Ni/40) + (Cr/5) + (Mo/4) + (V/14)$.